DIVISION 27

Telecommunications Standards for the Mike Monroney Aeronautical Center

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SECTION 27000 – GENERAL PROVISIONS FOR TELECOMMUNICATIONS SPECIFICATIONS

CONSTRUCTION STANDARD

1 PART: GENERAL

.1. RELATED DOCUMENTS

.1.1. Drawings and general provisions, including General and Supplementary Conditions and General Requirements (if any), are hereby made a part of this Section. Refer to paragraph titled "Telecommunications Subcontractor Qualifications" in this section for requirements for Telecommunications Subcontractors. Throughout this and related Sections, "Subcontractor" shall not be limited to the singular and masculine and shall refer to one, or more than one, Telecommunications Subcontractor.

.1.2. REFERENCE SPECIFICATIONS, STANDARDS AND CODES

.1.2.1. Comply with the referenced codes and standards with the documents. Where conflicts occur, the more stringent shall apply.

.1.2.2. Work shall meet or exceed the standards and procedures of the following:
American National Standards Institute (ANSI)
Telecommunications Industries Association (TIA)
Electronic Industries Association (EIA)
National Electrical Manufacturers Association (NEMA)
National Electrical Safety Code (NESC)
Institute of Electrical & Electronics Engineers (IEEE)
Underwriters Laboratories (UL)
National Fire Protection Association (NFPA)
American Standards Association (ASA)
Federal Communications Commission (FCC)
Occupational Safety and Health Administration (OSHA)
American Society of Testing Material (ASTM)

National Electric Code (NEC)
Americans with Disabilities Act (ADA)
In the event of conflicts, the more stringent provisions shall apply.

.1.2.3. Construction Project Manager (CPM): As defined for Sections referring to telecommunications work only, the CPM shall be the design analyst employed by the FAA for the purpose of observing the work of the Telecommunications Subcontractor.

.1.2.4. All Indefinite Delivery Requirements (IDR) contract work shall be turn-key. Telecommunications technicians shall perform all telecommunications work to include testing telecommunications cables prior to pull (fiber) , pulling telecommunications cables (copper and fiber), testing telecommunications cables after pull (copper and fiber), termination of telecommunications cables (copper and fiber) and final testing. Test results and as-built drawing to include telecommunications position numbers shall be provided to AMP-400. AMP-400 will provide test results and as-built drawings to include telecommunications position numbers to AMI-400 for approval and acceptance, prior to personnel occupying renovated or newly constructed area. IDR project manager shall provide.

.1.3. COORDINATION

.1.3.1. When articles, materials, operations or methods related to execution of telecommunications work are noted, specified, or described in the specifications of, are indicated or reasonably implied on drawings and schedules, execute work as required or appropriate to provide complete and proper function, operation and installation.

.1.3.2. The drawings utilize symbols and schematic diagrams to indicate items of work. These symbols and diagrams will not typically identify dimensions nor will they identify inclusion of specific accessories, appurtenances, and related items necessary and appropriate for a complete and proper installation and operation. The Telecommunications Subcontractor shall install work complete and ready for proper operation, including related items not specifically identified, shown, indicated or specified. The work shall be installed in accordance with the intent diagrammatically expressed on the drawings, and in conformity with the dimensions indicated on architectural drawings and on shop drawings approved by the Telecommunications Engineer. When abbreviations appear on the drawings or specifications in upper or lower case letters, with or without periods, the resultant work shall be as stated above.

.1.3.3. The drawings include details for various items, which are specific with regard to the dimensions and positioning of the work. These details are intended only for the purpose of establishing general feasibility. They do not obviate field coordination for the indicated work. Work shall not proceed until actual field conditions and requirements are verified by the Telecommunications Subcontractor.

.1.3.4. The drawings are diagrammatic and indicate the general arrangement of systems and equipment unless indicated otherwise by dimensions.

.1.4. DESCRIPTION OF SYSTEMS

.1.4.1. Furnish and install materials for the Telecommunications Infrastructure systems as specified herein and as shown on the drawings. Upon completion, the systems shall be functioning systems in compliance with performance requirements specified.

.1.4.2. The cabling specified and shown on the drawings is for complete, performance based, workable systems. Deviations from the cabling shown due to a particular manufacturer's requirements shall be made only with the written approval of the FAA and at no additional cost to the FAA.

.1.5. SUBMITTALS

.1.5.1. Submittals shall be made as one complete package.

.1.5.2. Submittals for individual systems and equipment assemblies, which consist of more than one item or component, shall be made for the system or assembly as a whole. Partial submittals will not be considered, reviewed or stored, and such submittals will not be returned except at the request and expense of the Contractor.

.1.5.3. Generate shop drawings on AutoCad, Version 2006 or later. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop drawings with record drawings in hard copy and an electronic copy. Electronic copies are to be written to CD or DVD if they cannot be provided through a shared drive.

.1.5.4. Shop drawings shall include equipment racks, patch panels, termination blocks, connection details, rack mounting details and any other details not included in the construction drawings.

.1.6. RECORD DRAWINGS

.1.6.1. Provide Record Drawings for requirements regarding Project Record Documents. "As-Built" record documentation for telecommunications work shall include:

System function diagrams
Manufacturers' description literature for equipment
Connection and programming schedules as appropriate
Equipment material list including quantities
Spare parts list with quantities
Details not on original Contract Documents
Test Results
Warranties
Release of Liens

.1.6.2. Operation and Maintenance Manual:

.1.6.2.1. The Telecommunications Subcontractor shall submit manuals that will contain manufacturers' brochures of items installed by the Telecommunications Subcontractor.

.1.6.2.2. The manual shall be subdivided into separate sections with tab dividers to identify subsystems of the integrated system. Reference appropriate specification sections.

.1.6.2.3. Provide the following additional information for each electronic system. Information shall be edited for this project where applicable.

- Operations manuals for components and for system as a whole.
- Maintenance Manuals for components and for system as a whole.
- Point-to-point diagrams, cabling diagrams, construction details and cable labeling details.
- List of spare parts, materials and suppliers of components.
- Provide name, address and telephone number for each supplier.
- Emergency instructions for operational and maintenance requirements.
- Delivery time frame for replacement of component parts from suppliers.
- Recommend inspection schedule and procedures for components and for system as a whole.
- Complete "Reviewed" shop drawings and product data for components and system as a whole.
- Troubleshooting procedures for each system and for each major system component.

.1.7. QUALITY ASSURANCE

.1.7.1. Equipment and materials required for installation under these specifications shall be the current model and new (less than one year from date of manufacture), unused and without blemish or defects.

.1.7.2. Manufacturers of equipment and materials, pertinent to these items shall have been engaged in the manufacture of said equipment a minimum of three years.

.1.7.3. Provide a written quality assurance plan for approval by the FAA including testing, plan for pre-testing and for final testing and certification of pre-testing and commissioning prior to final testing. Ensure compliance with Contract Documents. Include back-check as part of testing plans.

.1.7.4. Manufacturers: Firms regularly engaged in the manufacture of cable and devices of the types and capacities required, whose products have been in satisfactory use in similar service for not less than 3 years.

.1.7.5. EIA/TIA Compliance: Comply with applicable portions of Telecommunications Industry Association/Electrical Industry Association standards pertaining to cable, wire and connectors.

.1.7.6. UL Labels: Provide cable, wire and connectors, which have been approved, listed and labeled by Underwriters Laboratories.

.1.7.7. Installers: Installers shall be certified for installation of the Lucent Gigamax Level 6 cable system specified, and shall provide written warranty from the manufacturer to guarantee the installed system performance at the data throughput level as specified.

.1.8. TELECOMMUNICATIONS SUBCONTRACTOR QUALIFICATIONS

.1.8.1. General: The telecommunications subcontractor shall have total responsibility for the coordination and installation of the work shown and described in the telecommunications drawings and specifications. The telecommunications subcontractor shall be a company specializing in the design, fabrication and installation of integrated telecommunications systems.

.1.8.2. Telecommunications systems specified shall be engineered, assembled and installed under the direction of a pre-qualified telecommunications subcontractor. Pre-qualification requirements shall include submittal by the telecommunications subcontractor to the architect of the following:

.1.8.2.1. List of previous projects of this scope and nature, including names and sizes of projects, description of work, times of completion and names of contact persons for reference.

.1.8.2.2. Installers shall certify that they are manufacturer-authorized for work to be performed.

.1.9. COORDINATION WITH OTHER TRADES

.1.9.1. The telecommunications subcontractor shall coordinate telecommunications work with that of other sections as required to ensure that the entire telecommunications work will be carried out in an orderly, complete and coordinated fashion.

.1.10. WARRANTY

.1.10.1. Warranty work is to be free from defects. Repair or replace defective materials or workmanship, as well as damage to the work of other trades resulting from same, as directed by the FAA for the duration of the stipulated warranty period.

.1.10.2. The primary suppliers of telecommunications hardware and software shall warranty, through the telecommunications subcontractor, in writing, phases of systems (including but not limited to, software, hardware, peripheral equipment) against defective materials, design and workmanship. Upon receipt of notice from the FAA of failure of the system, or parts thereof, the telecommunications subcontractor, with the assistance of the supplier, shall promptly restore the defective component to provide an acceptable system at no cost to the FAA. The telecommunications subcontractor shall warranty the performance of the system for its intended use for a period of 1 year from the date of final acceptance, and shall "pass-through" and shall activate the manufacturers' warranties to the FAA for the full extent and period of the manufacturer's warranty.

.1.10.3. The warranty period shall commence upon final acceptance of the work by the FAA. Acceptance tests and procedures shall be developed by the telecommunications subcontractor in accordance with the provisions of this specification and accepted by the FAA. The telecommunications subcontractor shall test the installed systems in accordance with the accepted test procedures.

.1.10.4. Acceptance by a manufacturer of an order for equipment for this contract signifies acceptance of specified warranty requirements.

.1.10.5. During the warranty period, there shall be no charges to the FAA for service calls (mileage, labor, travel, expenses, etc.) for warranty related work.

.1.11. DESCRIPTION OF WORK

.1.11.1. The extent of telephone and data work is indicated by drawings and schedules, and by the requirements of this section.

.1.11.2. The types of components required for the project include the following:

Riser Cable – Fiber and Copper

Station Cable

Jacks and Mounting Frames

Termination Equipment – Fiber and Copper

Product Data: Cable, jacks, termination equipment and accessories

All above equipment is contractor furnished and installed on all IDIQ projects.

.1.12. SUBMITTALS

.1.12.1. The FAA Telecommunications Services Management section must approve any proposed substitutions for the specified telecommunications cables. Proposed substitutions are to be coordinated through AMP-400.

.2. PART: PRODUCTS

.2.1. GENERAL

.2.1.1. For each system, provide all wire, cable, jacks, termination accessories and other components as required to form a complete system of the types indicated or specified.

.2.2. MATERIALS

.2.2.1. Manufactured Products:

.2.2.1.1. Material and equipment furnished shall be of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

.2.2.1.2. When more than one unit of the same class of equipment or material is required, such units shall be the products of a single manufacturer.

.2.2.2. Equipment Assemblies and Components:

.2.2.2.1. Components of an assembled unit need not be products of the same manufacturer, but must meet TIA/EIA Category 6 criteria as a complete link system.

.2.2.2.2. Manufacturers of equipment assemblies, which include components made by others, shall assume complete responsibility for the final assembled unit.

.2.2.2.3. Components shall be compatible with each other and with the total assembly for the intended service.

.2.2.2.4. Moving parts or elements of equipment of the unit normally requiring lubrication shall have means provided for such lubrication and shall be adequately lubricated at the factory prior to delivery.

.2.2.2.5. Factory cabling shall be identified on the equipment being furnished and on cabling diagrams.

.2.2.3. Cable:

.2.2.3.1. Fiber Optic Riser Cable:

- 50 Micron Indoor or Outdoor Fiber Riser Rated Cable (as determined, whether plenum or non-plenum cable is required) or approved equal (number of strands to be supplied by AMI-400).
- Multimode and single mode (number of multimode and single mode to be supplied by AMI-400).

.2.2.3.2. Copper Telecommunications Riser Cable:

- 24 AWG, Level 3, Anixter # CMR-02004EAA (number of pair to be supplied by AMI-400)

.2.2.3.3. Station Cable

- 4 pair, 24 AWG, Level 6, Berk-Tek 10136339.
- 2 cables to each jack. One cable level 6, 24 gauge, 4 pair for the 2 RJ-11's. The other cable level 6, 24 gauge, 4 pair for the RJ-45.

.2.2.4. Telephone and Data Receptacles:

.2.2.4.1. Provide each telephone and data outlet with the following components (No substitutions allowed):

Description	Comcode Number
1 ea – RJ-45 Connector (Orange & Black)	MGS400BH-112

2 ea – RJ-11 Connector (Ivory)	107322158
1 ea – Blank	107067860
1 ea – Frame	106622277

.2.2.4.2. Some locations as indicated on the drawings will require one additional RJ-45 Connector.

.2.2.5. Telephone and Network Equipment:

.2.2.5.1. Provide and install the following equipment as required (report any substitution prior to installation to AMI-400):

Description	Catalog Number	Unit
72 Fiber Distribution Box	CPH-072	EA
ST Connectors	95-100-01R	EA
300 Pair Block with legs	107059917	EA
188 with Legs	104405113	EA
Avaya 6 Port Face Plate	108168592	Pack
48 Port Patchmax CAT 6	700173743	EA
110-C4	103801247	Pack
19" Rack	46353-503	EA
110-C5	103801254	Pack
Quad Frame	106622277	EA
ST Panel	FDC-CPIP-25	EA
Blue Label	106657174	Pack
Cable Mount	TMEH-58-C0	Pack
WIC Box	WIC-012-15	EA
24 Port Patchmax CAT 6	760062356	EA
Cable Management Racks	11729-703 Black	EA
Stainless 8.5" Preformed OSP Splice Can	8006330	EA
Endplate	8003542	EA
100 PR Building Entrance Protector	107894925	EA
2200VA Smart UPS	APC SU2200NET	EA
L5-20, 5-20,5-15 SU2200/3000	APC SU029	EA
Power-Net Smart-Slot Adapter for Ethernet	APC AP9605	EA
SC to ST Dual Fiber Jumpers, 62.5/125, MM (3 meters)	Siecor	EA
MIC (FDDI) to ST Dual Fiber Jumpers, 50 Micron, MM (3 meters)	Siecor	EA
Grounding Kit for 7' Rack	CPI 41026-001	EA
J-Bolt Kit	CPI 11308-001	EA
Wall Angle Support Kit for 9" Cable Runway	CPI 11421-109	EA
Rack to Runway Mounting Plate for 9' to 12"	CPI 10595-112	EA

Description	Catalog Number	Unit
Butt Splice Kit	CPI 11301-001	EA
PCMCIA 10/100 Ethernet Adapter	3Com 3CCFE575BT	EA
Cisco Small Form Factor MM GBIC	GLC-SX-MM	EA
Cisco Small Form Factor LH GBIC	GLC-LH-SM	EA
Jumper Trough Block	107831141	EA
1U Rack Mountable Fiber Box	CCH-01U	EA
2U Rack Mountable Fiber Box	CCH-02U	EA
Berk-Tek Level CAT 6 Four Pair Station Cable Non-Plenum	10136339	FT
50 Micron MM ST to ST Fiber Jumper 3 Meter	Generic	EA
50 Micron MM ST to ST Fiber Jumper 5 Meter	Generic	EA
50 Micron MM ST to ST Fiber Jumper 10 Meter	Generic	EA
50 Micron MM ST to SC Fiber Jumper 5 Meter	Generic	EA
50 Micron MM ST to SC Fiber Jumper 10 Meter	Generic	EA
50 Micron MM LC to ST Fiber Jumper 3 Meter	Generic	EA
50 Micron MM LC to ST Fiber Jumper 5 Meter	Generic	EA
50 Micron MM LC to ST Fiber Jumper 10 Meter	Generic	EA
50 Micron MM LC to SC Fiber Jumper 3 Meter	Generic	EA
50 Micron MM LC to SC Fiber Jumper 5 Meter	Generic	EA
50 Micron MM LC to SC Fiber Jumper 10 Meter	Generic	EA
8.3/125 SM LC to ST Fiber Jumper 3 Meter	Generic	EA
8.3/125 SM LC to ST Fiber Jumper 5 Meter	Generic	EA
8.3/125 SM LC to ST Fiber Jumper 10 Meter	Generic	EA
Uninterruptible Power Supply	APC 1500	EA
Management Card	APC 9617	EA
Cisco	G5485 1000 Base-SX	EA
LC MM Fiber Connectors	95-050-99	EA
LC SM Fiber Connectors	95-200-99	EA
Fiber Rack Mountable Enclosure	CCH-04U	EA
Fiber Cable Management	CJP-02U	EA
LC Fiber Panel	CCH-CP12-E4	EA
LC SM Fiber Panel	CCH-CP12-A9	EA
Fiber Fan-Out Kit	FAN-BT25-12	EA
36 x 36 , SM 50 Micron 50 um armored loose tube outdoor 36 MM/36 SM Fiber w/12 Fibers Per Tube	LE072XC6201S1	FT
Cable Runway Ladder Rack 9' xx.5" x 12' W Straight	CPI 10250-712	EA
Cable Runway Mounting Plate 12" w/Angle Support Kit	CPI 11421-712	EA
Cable Runway J-Bolt Kit, Runway To Wall Support Bracket	CPI 11308-001	EA
Cable Runway End Caps	CPI 10642-001	EA
Triangular Support Brackets	CPI 11746-712	EA
Cable Runway Junction Splice Kit Gold	CPI 16302-001	EA

Description	Catalog Number	Unit
Rack To Runway Mounting Plate	CPI 10595-712	EA
Butt Splice Kit UL-Classified Gold	16301-001	EA
Cisco 6509 Supervisor	VS-720-10G	EA
SUT 6000XLT	APC6000	EA
12 Strand 50 Micron Indoor Fiber Riser Rated	012C81-33131-24	FT
12 Strand 50 Micron Outdoor Riser Rated	012CSF-T4131D20	FT
24 Strand 50 Micron Indoor Fiber Riser Rated	024C81-33131-24	FT
24 Strand 50 Micron Outdoor Riser Rated	024C8F-33131-24	FT
Cisco Standard 24 Port Switch	WS-C3750-24TS	EA
Cisco SmartNet Maintenance for 24 Port Switch	CON-SNT-WS-C3750-24TS-8X5XNBD	EA
Cisco In-Line Power 24 Port Switch (POE)	WS-C3750-24-PS	EA
Cisco SmartNet Maintenance for 24 Port Switch (POE)	CON-SNT-WS-C3750-24-PS-7X5XNBD	EA
Cisco 24 Port Switch (gig to the desktop)	WS=C3750G-24T-S1U	EA
Cisco SmartNet Maintenance for 24 Port Switch (gig)	CON-SNT-WS-C3750G-24T-S1U-8X5XNBD	EA
Cisco Standard 48 Port Switch	WS-C3750-48TS	EA
Cisco SmartNet Maintenance for 48 Port Switch	CON-SNT-WS-C3750-48TS-8X5XNBD	EA
Cisco In-Line Power 48 Port Switch (for VoIP)	WS-C3750-48T-PS	EA
Cisco SmartNet Maintenance for 48 Port Switch (VoIP)	CON-SNT-WS-C3750-48-PS-8X5XNBD	EA
Cisco 48 Port Switch (gig to the desktop)	WS-C3750G-48T	EA
Cisco SmartNet Maintenance for 48 Port Switch (gig)	CON-SNT-WS-C3750G-48T-8X5XNBD	EA
Cisco 12 Port Switch (feeder switch w/routing)	WS-3750G-12S-E	EA
Cisco SmartNet Maintenance for 12 Port (feeder switch)	CON-SNT-WS-3750G-12S-E-8X5XNBD	EA
Cisco 12 Port Switch (feeder switch w/o routing)	WS-3750G-12S-S	EA
SmartNet Maintenance for 12 Port Switch (feeder switch w/o routing)	CON-SNT-WS-3750-125-S-8x5xNBD	EA
4400 WLAN Controller	AIR-WLC4404-100-K9	EA
SmartNet Maintenance for Controller	CON-SNT-WC440410	EA
Cisco WCS w/Location Expansion License	AIR-WCS-WLL-100EX	EA
Cisco Wireless Services Module (WISM)	WS-SVC-WISM-1-K9	EA
SmartNet 8X5XNBD Cisco wireless svc module (WISM)	CON-SNT-WSSVCW1K	EA
1240 Series Access Point	AIR-LAP1242AG-A-K9	EA
SmartNet Maintenance for AP's	CON-SNT-LAP1242A	EA
1140 Series Single Band Access Point	AIR-LAP1141N-A-K9	EA
SmartNet Maintenance for 1140 AP's	CON-SNT-LAP1141A	EA

Description	Catalog Number	Unit
1140 Series Dual Band Access Point	AIR-LAP1142N-A-K9	EA
SmartNet Maintenance for 1140 AP's	CON-SNT-LAP1142NAK	EA
Omni Ceiling Antenna	AIR-ANT5959	EA
Power Injector for 1240 Series	AIR-PWRINJ3	EA
Power Injector for 1140 Series	AIR-PWRINJ4	EA
Diversity Patch Wall Mount Antenna	AIR-ANT2465P-R	EA
1020 Series Access Point	AIR-AP1020-A-K9	EA
Uninterruptible Power Supply	APC-1500	EA
Uninterruptible Power Supply	APC-2200	EA
Uninterruptible Power Supply	APC-6000	EA
NIC for Uninterruptible Power Supply	APC-9617	EA
WRS/WRP Series Low Profile Wall Mount Rack Black	WRP-6	EA
65Db 800 MHz BDA Cellphone Mate	EM800-65	EA
½" Foam Cable	70393	FT
65Db 1900MHz BDA Cellphone Mate	CM1900-65	EA
N Male Crimp ½ Rapid Fit Connector	486060	EA
800-2500 Unequal Splitter	43553	EA
Diplexer Filter Cell/GSM	417677	EA
700-2700 2-Way Equal Splitter	432599	EA
Dual Band Dome Antenna	501123	EA
12 Db Yagi	824896	EA
Cell-PCS Dual Band 1850-199 MHz Yagi Antenna	496373	EA
½" Ground Kit	444197	EA
Lighting Arrester	491574	EA
Bulkhead Flange Adapter	38195	EA
2 Ft RG8 Cable W/N Male Connectors #951113	W07-0707-1-2FT	EA
	AIR-LAP1242AG-A-K9	
	CON-SNT-LAP1242A	
	AIR-LAP1141N-A-K9	
	CON-SNT-LAP1141A	
	AIR-ANT5959	
	AIR-PWRINJ3	
	AIR-ANT2465P-R	
	AIR-AP1020-A-K9	
5 Ft BL Cat 6 Patch Cord	EV06-05-BL	EA
5 Ft YL Cat 6 Patch Cord	EV06-05-YL	EA
5 Ft GY Cat 6 Patch Cord	EV06-05-GY	EA
15 Ft BL Cat 6 Patch Cord	EV06-15-BL	EA
15 Ft YL Cat 6 Patch Cord	EV06-15-YL	EA
15 Ft GY Cat 6 Patch Cord	EV06-15-GY	EA

Description	Catalog Number	Unit
25 Ft BL Cat 6 Patch Cord	EV06-25-BL	EA
25 Ft YL Cat 6 Patch Cord	EV06-25-YL	EA
25 Ft GY Cat 6 Patch Cord	EV06-25-GY	EA
Black Box 10 Base-T/100 Base-TX Ethernet Extender over VDSL	LB300A-R3	As Approved

.3. PART: EXECUTION

.3.1. INSTALLATION

.3.1.1. Install telephone and data products in accordance with the manufacturer's written instructions, the applicable requirements of TIA/EIA, and in accordance with recognized industry practices to ensure that products serve the intended function.

.3.1.2. All telephone and data cables shall be installed in conduit per blueprint requirements. The established minimum conduit size is ¾".

.3.1.3. Bond riser cables to the ground bar at both ends.

.3.1.4. Terminate all pairs and fiber strands of riser cables.

.3.1.5. Contractor shall mount racks in telephone rooms and equipment in the racks as specified in the MMAC Telecommunications Generic Specifications Section. Configuration and turn-up shall be accomplished by FAA, AMI-400.

.3.1.6. Installation of all termination equipment and other work in telephone equipment room shall be accomplished under the direction of FAA AMI-400 personnel. Bundle cables and secure with Velcro hook & loop, and provide cable rings as required to neatly train all cables. Label all cables in accordance with FAA standard nomenclature using approved labeling material as specified in the Jack Labeling Section.

.3.1.7. Fiber Optic splices shall not be allowed unless specifically called for on the drawings. Where fiber optic splices are specifically called for, provide fusion splices. Maximum allowable splice attenuation for single-mode or multi-mode fiber shall be 0.05 dB. Submit printout documentation showing the splice loss of each strand.

.3.1.8. Junction Boxes shall be 18"x18"x10". If the stated size floor box cannot be installed due to space restrictions, consult the Voice/Data Communications team of the Telecommunications Division at 954-3651 to submit request for substitution with the next appropriate size junction box.

.3.1.9. Turns in conduit shall be wide sweep turns with no bend in conduit greater than 90° or an aggregate of bends in excess of 180° between pull points or pull boxes. For runs that total more than 100 feet in length, pull points or pull boxes shall be inserted so that no segment between points/boxes exceeds the 100 foot limit. Any turn greater than 90° will require installation of a junction box. If junction box is required, contact Voice/Data Communications team of the Telecommunications Division at 954-3651 for determination of junction box size requirement. Conduit shall be bonded to ground on one or both ends.

.3.2. EXAMINATION OF SURFACE CONDITIONS

.3.2.1. Prior to the start of work, the telecommunications subcontractor shall carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.

.3.2.2. Install equipment in accordance with applicable codes and regulations, the original design and the referenced standards.

.3.2.3. In the event of discrepancy, immediately notify the AMP Project Manager.

.3.2.4. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

.3.3. TESTING

.3.3.1. Fiber Optic Cable Testing:

.3.3.1.1. Contractor shall perform an Optical Time Domain Reflector (OTDR) test to verify integrity of the cable when received from the manufacturer (test cable on the reel) and again to ensure the cable was not damaged during the installation.

.3.3.1.2. Contractor shall perform an end-to-end attenuation test to verify proper termination of each fiber.

.3.3.1.3. Contractor shall submit two copies of each test to the Contracting Officer for acceptance and approval by the FAA. Contractor shall replace any defective or noncompliant cable at no additional cost to the FAA.

.3.3.2. OTDR Testing:

.3.3.2.1. Upon delivery of the cable to the jobsite, and prior to installation, test each strand of all cable with Optical Time Domain Reflectometer (OTDR) with multi-mode and single-mode modules. Provide printouts to document that all fiber optic strands meet specified criteria before installation.

.3.3.2.2. After cable placement, perform a second OTDR test to verify the cable was not damaged during installation; also verify distances of cable runs and system integrity. Enter all results into the system documentation.

.3.3.2.3. After strands are terminated, perform an OTDR end-to-end test from each end to prove the terminations. Enter all results into the system documentation.

.3.3.2.4. Single mode fiber will be tested at 1310 nm and 1550 nm. Multi mode fiber will be tested at 850 nm and 1300 nm.

.3.3.3. Performance Specifications:

.3.3.3.1. Cable shall meet the following minimum specifications:

Maximum Attenuation:
3.5 dB at 850 nm
1.0 dB at 1300 nm

Minimum Bandwidth:
200 MHz.km at 850 nm
500 MHz.km at 1300 nm

Single Mode Specification:
0.4 dB at 1310 nm
0.3 dB at 1550 nm

.3.3.4. Copper Riser Cable Testing:

.3.3.4.1. Riser Cable Testing:

.3.3.4.1.1. End –To-End Polarity Testing: A minimum of 99% pair functional connectivity shall be verified by end-to-end polarity testing. Polarity test shall verify correct tip, ring and pair.

.3.3.4.1.2. TDR Test: Perform a Time Domain Reflectivity test to verify splices and correct gauge of wire throughout the run.

.3.3.4.1.3. Documentation: Provide complete documentation of each test performed and printout of TDR test.

.3.3.4.1.4. Contractor shall submit two (2) copies of each test to the Contracting Officer for acceptance and approval by the FAA. Contractor shall replace any defective or noncompliant cable at no additional cost to the FAA.

.3.4. PROTECTION OF SYSTEMS AND EQUIPMENT

.3.4.1. Asbestos Survey: Prior to the disturbance of any building materials, construction personnel must know the results of an asbestos survey.

.3.4.2. Lead Survey: Prior to the disturbance of any building materials, construction personnel must know the results of a lead survey.

.3.4.3. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials shall be protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature and rain.

.3.4.4. Damage from rain, dirt, sun and ground water shall be prevented by storing the equipment on elevated supports and covering them on sides with securely fastened protective rigid or flexible waterproof coverings.

.3.4.5. During installation, equipment shall be protected against entry of foreign matter on the inside and be vacuum cleaned both inside and outside before testing, operating or painting.

.3.4.6. As determined by the AMI-400, damaged equipment shall be fully repaired or shall be removed and replaced with new equipment to fully comply with requirements of the documentation provided. Decisions of AMI-400 shall be final.

.3.4.7. Painted surfaces shall be protected with removable heavy Kraft paper, sheet vinyl or equal, installed at the factory and removed prior to final inspection. Damaged paint on equipment and materials shall be repainted with painting equipment and finished with same quality of paint and workmanship as used by the manufacturer.

.3.5. WORK PERFORMANCE

.3.5.1. Coordinate location of equipment and conduit with other trades to minimize interference.

.3.5.2. Holes through concrete and masonry in new and existing structures shall be cut with a diamond core drill or concrete saw upon approval of the structural engineer of record for the base building. Pneumatic hammer, impact electric, hand or manual hammer type drill shall not be allowed, except where permitted by the AMP Project Manager as required by limited working space.

.3.5.3. Holes shall be located so as not to affect structural sections such as ribs or beams.

.3.5.4. Holes shall be laid out in advance. The AMP Project Manager shall be advised prior to drilling through structural sections, for determination of proper layout.

.3.5.5. Structural Penetrations: Where conduit, wire ways and other raceways pass through fire partitions, fire walls or walls and floors, provide FAA approved effective barrier against the spread of fire, smoke and gases

.3.6. ACCESS TO EQUIPMENT

.3.6.1. Equipment shall be installed in location and manner that will allow convenient access for maintenance and inspection.

.3.6.2. Working spaces shall not be less than specified in the National Electrical Code for voltages specified.

.3.6.3. Where the AMP Project Manager determines that the telecommunications subcontractor has installed equipment not conveniently accessible for operation and maintenance, equipment shall be removed and reinstalled, one time only, as directed by the AMP Project Manager, at

no additional cost to the FAA. "Conveniently accessible" is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping and duct work.

.3.7. CABLE TERMINATION AND DRESS

.3.7.1. Installation of signal, video, and communication and control conductors shall adhere to the following:

.3.7.2. Cables shall be dressed, labeled and hook & loop wrap in cabinets, racks and/or at cross connect backboard to present a neat, logical and orderly installation. At the discretion of the telecommunications subcontractor, cable duct with removable covers may be installed in equipment cabinets and control consoles to facilitate satisfying this requirement.

.3.7.3. Cables shall be secured to equipment cabinet backboards, console members or to other system components using cable clamps and hook & loop wraps. The telecommunications subcontractor shall furnish and install cable support posts to facilitate system installation.

.3.7.4. Cables and conductors shall be terminated with cable termination connectors compatible with the specific termination.

.3.7.5. Metallic cables and conductors entering the facility from a point exterior to the building shall be equipped with lightning protection. Protector shall be located at the nearest point of cable entry in the building.

.3.8. UPS POWER

.3.8.1. Electrical circuits supplying power to system components contractor furnished, as part of telecommunications work shall be connected to existing UPS power, if provided as work of the section of Division 27.

.3.9. CLEANING

.3.9.1. During construction, and prior to FAA acceptance of the building, remove from the premises and dispose of packing material and debris caused by telecommunications work.

.3.9.2. Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current carrying elements prior to being energized.

.3.10. COMPLETION

.3.10.1. Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools and similar items. Leave the premises clean, neat and orderly.

.3.10.2. Systems shall be complete and operational and controls shall be set and calibrated.

.3.10.3. Testing, start-up and cleaning work shall be complete.

.3.10.4. Special tools for proper operation and maintenance of equipment provided under this specification shall be delivered to the FAA.

.3.10.5. All punch list items must be corrected prior to acceptance of project.

.3.11. TESTING AND VERIFICATION

.3.11.1. The telecommunications subcontractor shall verify that requirements of this specification are met. Verification shall be through a combination of analyses, inspections, demonstrations and tests, as described below.

.3.11.2. Verification by Inspection: Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the FAA.

.3.11.3. Verification by Test and Demonstration: The telecommunications subcontractor shall verify by formal demonstrations or tests that the requirements of this specification have been met. The telecommunications subcontractor shall demonstrate that the telecommunications systems components and subsystems meet specification requirements in the "as-installed" operating environment during the "System Operation Test." While no formal environmental testing is required, the telecommunications subcontractor shall measure and record temperature, humidity and other environmental parameters and the environmental conditions, which were encountered during the "System Operation Test."

.3.11.4. Perform commissioning and pretest prior to enclosure of walls.

.3.11.5. Perform system operation tests after full enclosure of walls.

.3.11.6.System Operation Tests Conducted Upon Completion Of Work: Upon completion of the telecommunications subcontractor's work, subject the system to functional and operational tests. When required, corrections determined by initial test results, have been completed, fully retest the system. The FAA shall be notified in writing not less than seven days in advance of date of proposed final testing and inspection. The advance notice shall include certification that the installation is complete and operable and that the telecommunications subcontractor has satisfactorily performed the final tests specified herein. The acceptance testing and final inspection shall be accomplished in the presence of the FAA and the AMP Project Manager. At least ten days prior to scheduled system completion, the telecommunications subcontractor shall submit, for approval by the FAA a test plan to completely test telecommunications systems. The telecommunications subcontractor shall include in test plan, for acceptance by the FAA (AMI-400 and the AMP Project Manager), a complete and detailed final acceptance test check-off list ("punch list). The list shall be a complete representation of specified functions and conditions, including contingency, priority and abnormal modes of operation. The arrangements of the list shall be such as to provide an orderly method of tabulating checks of system features, response and operation. The punch list shall include a designated space adjacent to each test procedure where the FAA can initial to indicate compliance with each test procedure. At the time of final acceptance testing, required tests shall be repeated and defects corrected until the system is found to be acceptable to AMI-400 and AMP. The telecommunications subcontractor shall maintain a log of test activities and results. Both electronic and printed copies of this log including copies of the signed-off punch list shall be submitted to the FAA within seven days of the testing. Final tests shall include, but not limited to, the following:

.3.11.7.Test all category cables in accordance with current TIA/EIA specifications for that category of cabling with a test device meeting or exceeding level IIe accuracy.

.3.11.8.Bi-directional attenuation (loss) test for each multimode fiber strand at 850nm and 1300nm wavelengths and each single mode fiber strand at 1310nm and 1550nm. Conduct tests in accordance with ANSI/TIA/EIA-526-14-A, Method B for multimode fibers, and ANSI/TIA/EIA-526-7, Method A.1 for single mode fibers and with test instrument manufacturers printed instructions. Demonstrate that measured link loss does not exceed the "worst case" allowable loss which is the sum of: the connectors loss (based on the number of mated connector pairs at the ANSI/TIA/EIA-568-A maximum allowable loss of 0.75dB per mated pair) and the optical fiber loss (based on the maximum allowable loss of 3.5 dB/km @ 850nm and 1.5 dB/km @ 1300nm for multimode fiber and 1.0 dB/km @ 1310nm and 1.0 dB/km @ 1550nm for indoor single mode fiber and 0.5 dB/km @ 1310nm and 0.5 dB/km @ 1550nm for outdoor single mode fiber).

.3.11.9. Visual inspection of cabling for proper routing bends radii cable management and security.

.3.11.10. Verification that required submittals have been provided and have been accepted.

.3.11.11. The telecommunications subcontractor shall carefully plan and coordinate the final acceptance tests so that tests can be satisfactorily completed. The telecommunications subcontractor shall provide necessary instruments, labor and materials required for tests, including the equipment manufacturer's technical representative and qualified technicians in sufficient numbers to perform the tests within a reasonable time period. The AmP-400 office reserves the right to be present during testing.

.3.11.12. After telecommunications systems have been installed and tested, the completed test plan shall be signed by the telecommunications subcontractor and submitted for approval.

.4. TELECOMMUNICATIONS JACK LABELING STANDARD

.4.1. Abstract:

.4.1.1. This standards statement documents the practice for labeling telecommunications jacks during the installation process. Telecommunications jacks shall be installed in accordance with the document titled "Approved Telecommunications Jack Cabling Standards." This standard requires that a unique position number be designated for each telecommunications jack. Additionally, this standard requires that the telephone closet that hosts the telecommunications jack will be identified in the position number of the telecommunications jack.

.4.2. Standard:

.4.2.1. The labeling standards define the labeling at the jack location as well as in the telephone closet. Based on the "Approved Telecommunications Jack Cabling Standards" one CAT 6 cable is placed to support multiple voice jacks. As this single cable is terminated on a wall mounted 110- block as a single position designation and jumpers are cross connected to support multiple voice jacks, the labeling scheme differs in the closet from the jack. In all cases the labels at the jacks and in the closet will be made with high contrast permanent material, which may be removed and replaced in the field.

.4.3. At The Jack:

.4.3.1. This standard defines a position as a location housing jacks whether it is a "tombstone," surface plug, power pole or a "Walker" box. A jack is the wiring device installed in a position, which allows for connection of the telecommunications device. The labeling number will be six characters in the format of:

CCCPPP

.4.3.2. The syntax of the label is:

<Closet Number><Position Number>

.4.4. At The Closet:

.4.4.1. This standard defines the nomenclature as a location designated on a designation strip on a Patch Panel or 110 Wall Mounted Block. The labeling number will be seven or eight characters in the format of:

TCCCPPPF

.4.4.2. The syntax of the label is:

<Jack Type><Closet Number><Position Number><Duplication Flag>

.4.4.3. Patch Panels will normally be designated as a Jack Type of L for LAN.

.4.4.4. The 110-block designation will be a Jack Type of V for Voice. On the 110 designation it will be understood that the Duplication Flag will increment as follows based on the pair selected:

Pair Color	Duplication Flag Designation
Blue	A
Orange	B
Green	C
Brown	D

Further Definitions:

Labeling Syntax	**Permitted Character**	**Permitted Value**	**Description**
Jack Type (Closet)	Alpha	V	Voice Jack
		L	LAN Jack
		S	Special

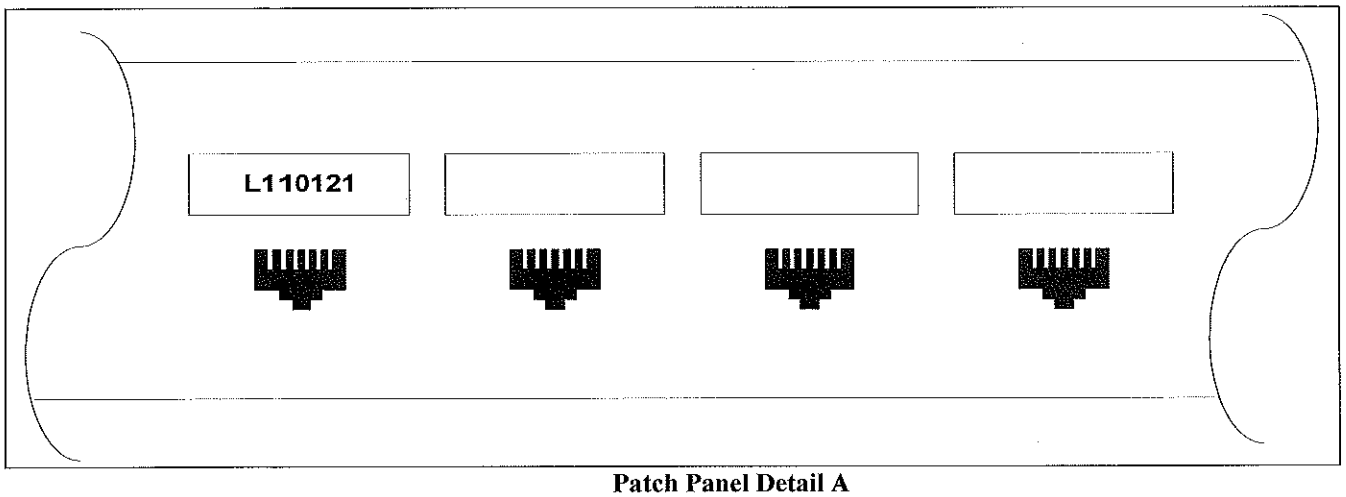
Closet Room Number	Alpha/Numeric	001-999 A-Z *	The room number of the serving closet as it will be labeled at contract completion. * (In cases where the closet number is larger than 3 characters, the closet number shall be trimmed to the useful three digits as determined by AMI-400, i.e. BC04G>C04 127B>127
Sequence Number	Numeric	001-999	This is a unique number for the position, which usually is the sequence number of when the jack was installed.
Duplication Flag	Alpha	A-D	If the descriptives are duplicated in an installation (i.e. multiple analog numbers at the same position.)

.4.5. **Example In Closet:**

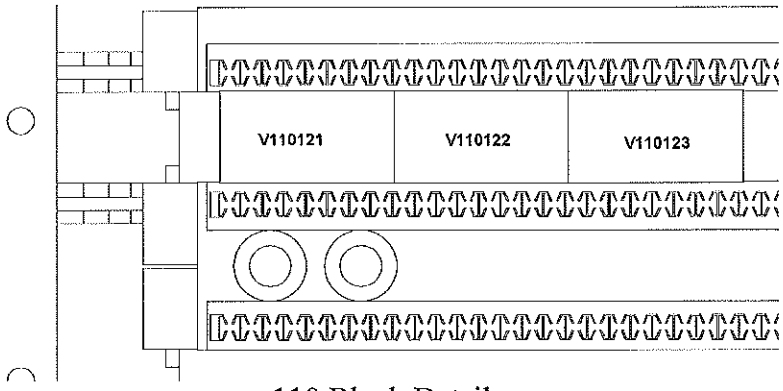
.4.5.1. Voice, LAN and analog circuits are installed to work out of closet 110. This is the 121st position installed in this closet. The jack number would be:

Voice: V110121A
Analog: V110121B (with the analog number posted by the jack when activated by a telephone work order.)
LAN: L110121

.4.5.2. In the closet, the LAN jack would be labeled on the supporting Patch Panel as L110121 (Figure A). The Voice and Analog cable would be installed on a 110-block and labeled V110121 below it (Figure B). On the 110-block, the "blue" pair would be the "A" jack and the "orange" pair would be the "B" jack.

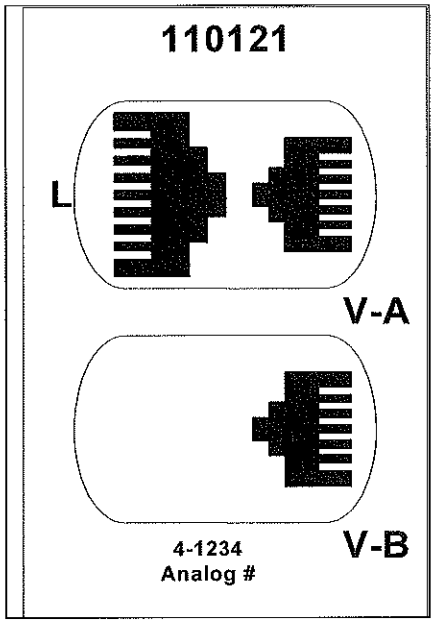


Patch Panel Detail A
Figure A



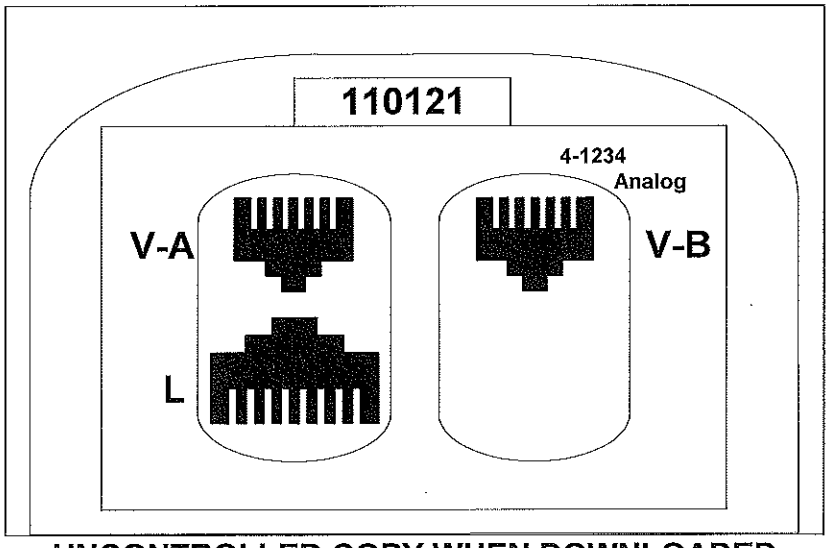
110 Block Detail
Figure B

.4.5.3. At the position with the jacks, on a quad plate, the upper left jack position is the LAN jack with the Orange Jack. The upper right position is the first Voice jack with an Ivory Jack. The lower right position is the second Voice jack with an Ivory Jack. If it is an analog line, the analog number will be indicated on the jack when an analog telecommunications work order is complete (Figure C).

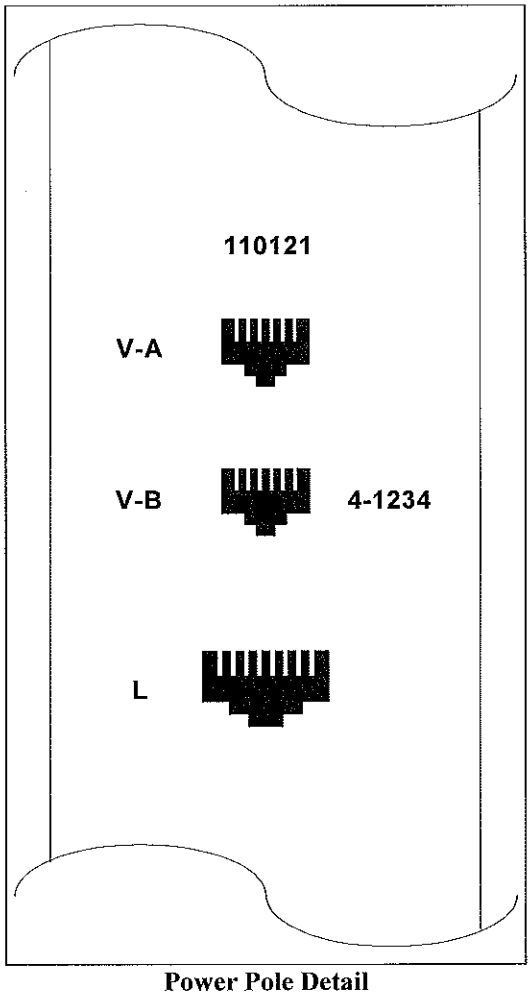


Quad Detail
Figure C

.4.5.4. Figure D (Tombstone Detail) and Figure E (Power Pole Detail) below extend the jack labeling to the "Tombstone" and "Power Pole" configuration. The "Walker Box" will use the "Quad" (Figure C) jack layout. Other configurations may be approved by AMI.



Tombstone Detail
Figure D

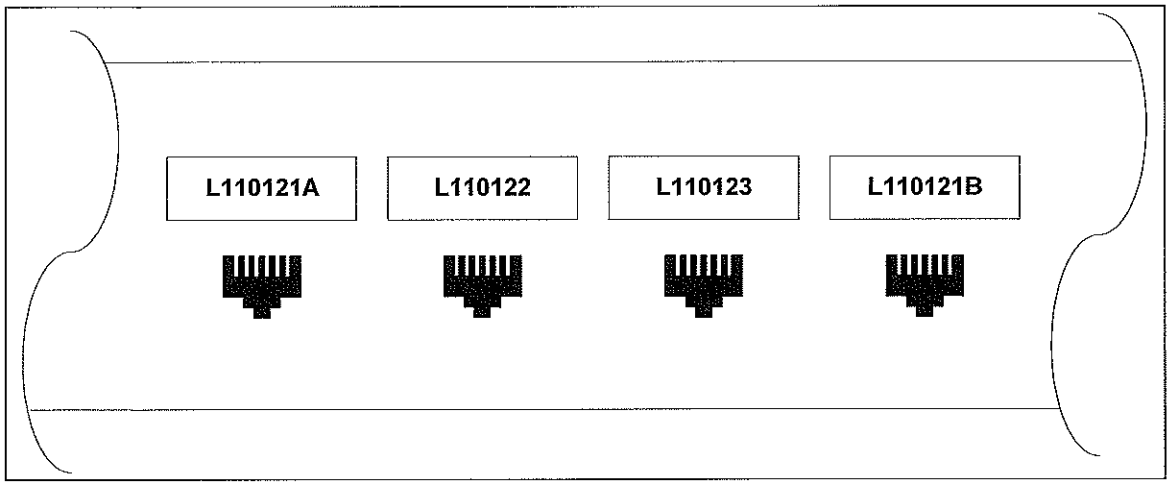


Power Pole Detail
Figure E

.4.6. Situation 2:

.4.6.1. A new work order is issued for a second LAN connection at the position installed in Situation 2. Its jack number would be L110121B. Re-label previous LAN connection from L to L-A.

.4.6.2. In the closet, the old jack on the Patch Panel is re-designated as L110121A. The second LAN jack is terminated in an open position on the Patch Panel and designated L110121B (Figure F)



Patch Panel Detail B

Figure F

.4.7. Exceptions To Standard:

.4.7.1. Every effort should be made to adhere to these standards for all new installations. When new wiring is pulled to an existing position labeled in the old style, the position and wiring may reflect the legacy and pre-existing style. New positions with new jacks shall adhere to the new labeling standard at the position. However, if the old legacy wiring standard is continuing in the closet where a single cable supports both Voice and LAN, then the closet block designation shall reflect just the closet and sequence number in the "CCCPPP" format. Existing jacks in the position with the old style label may remain in the old style.

.4.8. References:

Item	Description
Telecommunications Jack Cabling Standards, 7/22/99	Standards describing what material is required and how to wire telecommunications jacks.

.5. TELECOMMUNICATIONS JACK CABLING STANDARD

.5.1. ABSTRACT:

.5.1.1. This standards statement documents the material and practice for installing telecommunications jacks from a designated telephone closet to a designated telecommunications jack location which may be installed in a "Walker" Box, "Tombstone", Cubicle, Wall or Surface mounted apparatus.

.5.2. STANDARD:

.5.2.1. In accordance with EIA/TIA 568 and 569 series the primary method of meeting communications needs will be the installation of 4 pair Category 6 or better wiring (Berk-Tek is the current specification) as required. Generally, run one 4 pair wire for each LAN jack and one 4 pair wire to support two voice jacks, to the closest Telecommunications Closet. See Table I below for wire termination to jack pins.

.5.2.2. The current jack materials will also be rated for Category 6 or better.

.5.2.3. A manufacturer's certified technician to sustain the manufacturer's performance warranties will perform all wiring for telecommunications.

Table I

Pair	Wire Color	LAN Jacks Pin Out (T568B)	First Phone Pin Outs (Color)	Second Phone Pin Outs (Color)
1	Blue	4	3	*
1	Blue-White	5	4	*
2	Orange	2	*	3
2	Orange-White	1	*	4
3	Green	6		*
3	Green-White	3		*
4	Brown	8		*

4	Brown-White	7		*

a) Unused wires should be tied back for future use.

.5.3. EXCEPTIONS TO STANDARDS:

.5.3.1. In the building spaces not yet renovated at the Aeronautical Center, ducts and conduits may not be sufficient to support this standard. In those cases, AMI-400 will provide wiring guidance as necessary.

.5.4. REFERENCES:

EIA/TIA 568-A	Commercial Building Telecommunications Wiring Standard.
EIA/TIA-569	Commercial Building Standard for Telecommunications Pathway and Spaces
EIA/TIA-606	Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
TSB 36	Technical Systems Bulletin-Additional Cable Specifications for Unshielded Twisted Pair Cables
TSB 40	Technical Systems Bulletin-Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware
IEEE 802.3	Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications

.6. COPPER/FIBER SPLICING STANDARD

This document constitutes the copper and fiber cable-splicing standard for the Mike Monroney Aeronautical Center (MMAC).

.6.1. SCOPE

.6.1.1. This standard describes approved methods for splicing plastic insulated copper and fiber optic cables. Typical applications of these methods include aerial, buried and underground splices.

.6.1.2. Copies of the American National Standard Institute/National Fire Protection Association (ANSI/NFPA) 70, National Electrical Code (NEC), referenced in this standard, can be obtained from NFPA, Batterymarch Park, Quincy, Massachusetts 02269, at telephone number 1 (800) 344-3555.

.6.1.3. Copies of the American National Standard Institute/Institute of Electrical and Electronics Engineers, Inc. (ANSI/IEEE), National Electrical Safety Code (NESC), referenced in this standard, can be obtained from IEEE Service Center, 455 Hoes Lane, Piscataway, New Jersey 08854, telephone number 1 (800) 678-4333.

.6.1.4. Copies of the Rural Utilities Services (RUS) standards and forms can be obtained from Mr. Charlie Harper at the Rural Utilities Service of the United States Department of Agriculture. Mr. Harper may be contacted at (202) 720-0667 (telephone), (202) 760-4099 (Fax) or by electronic mail at charper@rus.usda.gov.

.6.2. GENERAL

.6.2.1. Only Federal Aviation Administration (FAA) accepted filled cable and splicing materials are to be used on outside plant projects on FAA property.

.6.2.2. The installation instructions provided by the manufacturer of splicing materials shall be followed except where those instructions conflict with the procedures specified in this standard.

.6.2.3. Precautions shall be taken to prevent the ingress of moisture and other contaminants during all phases of the splicing installation. When an uncompleted splice must be left unattended, it shall be sealed to prevent the ingress of moisture and other contaminants.

.6.2.4. Minor sheath damage during construction may be repaired if the repair is completed immediately and is approved by the FAA representative. Minor damage is typically repaired by:

.6.2.4.1. Scuffing the cable sheath associated with the damaged area;

.6.2.4.2. Applying several layers of DR tape over the scuffed and damaged area;

.6.2.4.3. Applying several layers of plastic tape over the DR tape; and

.6.2.4.4. If damage is severe enough to rupture the cable shield, a splice closure shall be installed.

.6.2.5. All splice cases installed on all FAA outside plant cables shall be filled, whether aerial, buried, or underground.

.6.3. SPLICING CONSIDERATION FOR COPPER CABLES

.6.3.1. Pre-construction Testing: It is desirable that each reel of cable be tested for grounds, opens, shorts, crosses and shield continuity before the cable is installed. However, manufacturer supplied test results are acceptable. All cable pairs shall be free from electrical defects.

.6.3.2. Handling Precautions: The cable manufacturers' instructions concerning pulling tension and bending radius shall be observed. Unless the cable manufacturer's recommendation is more stringent, the minimum-bending radius shall be ten times the cable diameter for copper cables and twenty times the cable diameter for fiber optic cables.

.6.3.3. Cable Sheath Removal:

.6.3.3.1. The length of cable sheath to be removed shall be governed by the type of splicing hardware used. Follow the splice case manufacturer's recommendations. For pedestals or large pair count splice housings, consider removing enough cable sheath to allow the conductors to extend to the top of the pedestal and then hang downward to approximately 15 centimeters (cm) (6 inches (in.)) above the base plate.

.6.3.3.2. Caution shall be exercised to avoid damaging the conductor insulation when cutting through the cable shield and removing the shield. Sharp edges and burrs shall be removed from the cut end of the shield.

.6.4. SHIELD BONDING AND GROUNDING:

.6.4.1. For personnel safety, the shields of the cables to be spliced shall be bonded together and grounded before splicing activities are started. (See Paragraphs 7.2 and 7.5.1 through 7.5.3 of this standard for final bonding and grounding provisions.)

.6.5. BINDER GROUP IDENTIFICATION:

.6.5.1. Color-coded plastic tie wraps shall be placed loosely around each binder group of the cables before splicing operations are attempted. The tie wraps shall be installed as near the cable sheath as practicable and shall conform to the same color designations as the binder ribbons. Twisted wire pigtails shall not be used to identify binder groups due to potential transmission degradation.

.6.5.2. The standard insulation color code used to identify individual cable pairs within 25-pair binder groups shall be as shown in Table I:

TABLE I

Cable Pair Identification Within Binder Groups

Pair #	Tip	Ring
1	White	Blue
2	White	Orange
3	White	Green
4	White	Brown
5	White	Slate
6	Red	Blue
7	Red	Orange
8	Red	Green
9	Red	Brown
10	Red	Slate
11	Black	Blue
12	Black	Orange
13	Black	Green
14	Black	Brown
15	Black	Slate
16	Yellow	Blue
17	Yellow	Orange
18	Yellow	Green
19	Yellow	Brown
20	Yellow	Slate
21	Violet	Blue
22	Violet	Orange

23	Violet	Green
24	Violet	Brown
25	Violet	Slate